RESISTANCE TEST RESULTS FOR 1/12 SCALE MODELS OF THREE PLANNING CATAMARANS

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THE UNIVERSITY OF MICHIGAN
College of Engineering
Department of Naval Architecture and Marine Engineering
Ship Hydrodynamics Laboratory

RESISTANCE TEST RESULTS FOR 1/12 SCALE MODELS OF THREE PLANING CATAMARANS

by
James L. Moss

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Office of Research Administration

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Ann Arbor

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Still water resistance tests were conducted on three hard chine planing catamaran models. Total resistance, LCG rise and change in running trim were measured. Hull spacing and displacement were the fundamental parameters which were varied. The models were built to a linear scale ratio of 12:1 and represented a full scale boat length of 65 ft. overall. The full scale speed range was from 10 knots to 30 knots.

Two of the three hull designs were symmetric about the centerplane and differed from each other only in details of the lines. For instance, one design (model 1175), prepared by Charles W. Bond, a naval architect in Tampa, Florida, had a change in deadrise of 22 degrees from amidships to the transom. The other symmetric hull (model 1177), designed by Grafton Boat Co., had a change in deadrise of only 12 degrees over the same length. There were other, more subtle, differences in lines.

The third set of hulls were asymmetric about the centerplane. In fact, they were fabricated from an existing model of a conventional planing hull design of a 65 ft. Aluminum Survey Boat. The model was cut longitudinally on the centerplane so that two models resulted, each with one completely flat side. The flat sides were always towed on the inboard

side of the catamaran configuration and were always oriented fore and aft. This model was designated model 1179.

Lines of the different hulls are documented on Grafton Boat Co. drawings as follows:

Model No.	Drawing No.	Description
1175	DR 6813	dated 3/21/69
1177	DR 6813	dated 4/4/69, titled "Hull Lines 'C'"
1179	GL-6709-2	dated 8/14/67

Table 1 lists the test configurations according to the equivalent full scale displacements and hull spacings. Also indicated in Table 1 are the figures where the full scale performance predictions are graphed. Resistance and horsepower extrapolations have been made using the 1947 ATTC friction coefficients with zero correlation allowance. Turbulent flow on the models was stimulated by means of tape strips applied diagonally between the keel and chine.

In the figures, four quantities have been plotted. Center-of-gravity rise divided the cube root of the static volumetric displacement, C.G. Rise/$\nabla^{1/3}$, and change in running trim in degrees are non-dimensional and will be the same for any boat size running at equivalent Froude numbers. Effective horsepower and R_T/Δ, the reciprocal of lift-drag ratio, need to be

corrected for frictional resistance if powering predictions are required for a different boat size than that reported on here. Therefore, for purposes of extrapolation of model resistance to other boat sizes, an appendix which lists model speeds, resistances and wetted areas and lengths has been included.

TABLE 1

Test Configurations

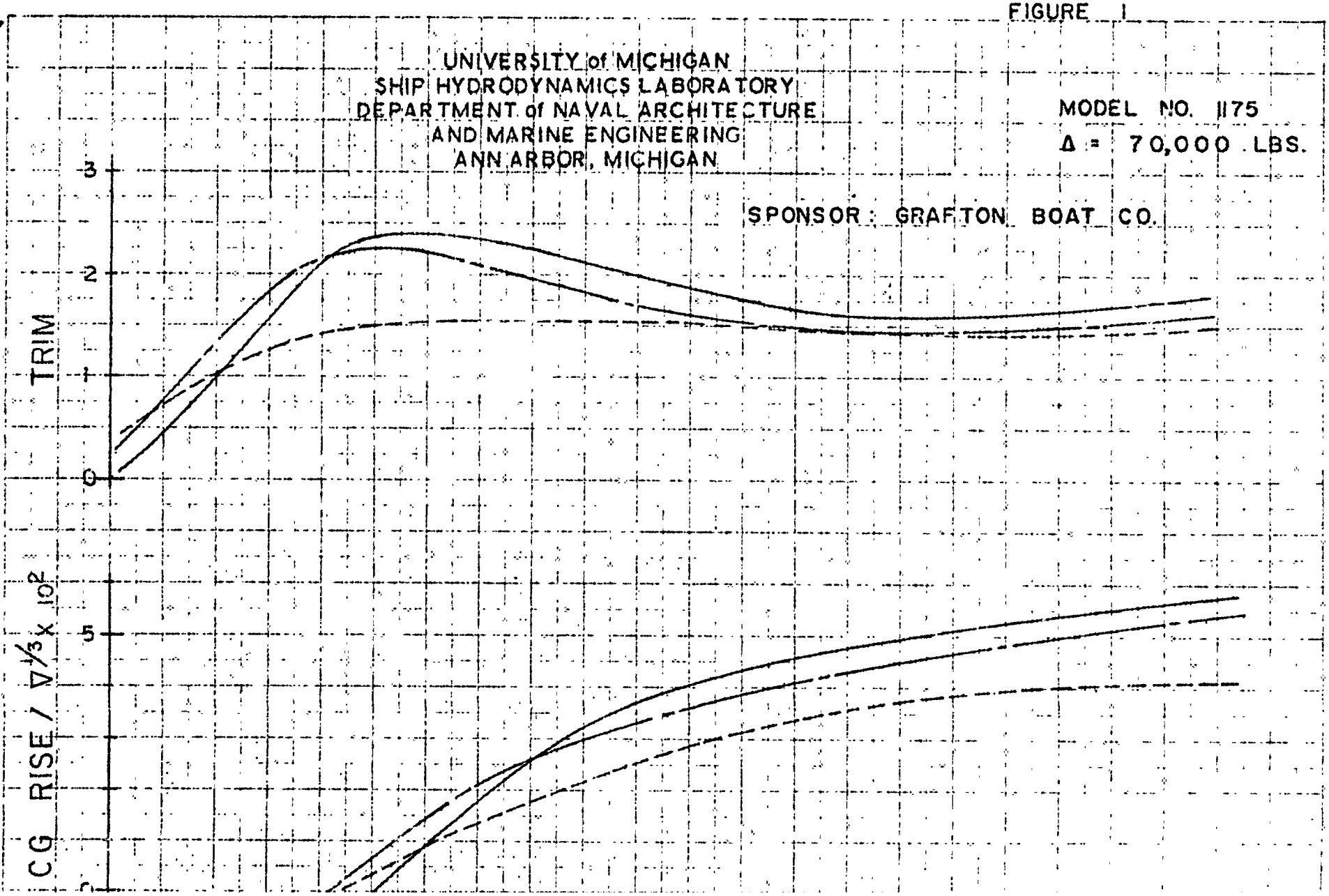
Model No.	Displacement lbs. full scale	Spacing* ft. full scale	Test Designation	Figure No.
1175	70,000	13.00	A1	1
	70,000	17.00	B1	1
	70,000	31.75	C1	1
	80,000	13.00	A2	2
	80,000	17.00	B2	2
	80,000	31.75	C2	2
	90,000	13.00	A3	3
	90,000	17.00	B3	3
	90,000	31.75	C3	3
1177	40,000		single hull †	4
	70,000	13.00	A1	5
	70,000	17.00	B1	5
	70,000	31.75	C1	5
	80,000	13.00	A2	6
	80,000	17.00	B2	6
	80,000	31.75	C2	6
	90,000	13.00	A3	7
	90,000	17.00	B3	7
	90,000	31.75	C3	7
1179	80,000	13.00	A2	8
	80,000	17.00	B2	8
	80,000	31.75	C2	8
	80,000	4.00	Mono-hull ‡	9

* For the symmetric hulls (1175 and 1177), the spacing is measured between hull centerplanes. For the asymmetric hulls (1179), the spacing is measured between the flat inboard surfaces plus four feet full scale.

† One-half of the catamaran.

‡ The two halves of the catamaran joined at the flat inboard surfaces.

FIGURE 1


UNIVERSITY of MICHIGAN
SHIP HYDRODYNAMICS LABORATORY
DEPARTMENT of NAVAL ARCHITECTURE
AND MARINE ENGINEERING
ANN ARBOR, MICHIGAN
MODEL NO. 1175
Δ = 70,000 LBS.
SPONSOR: GRAFTON BOAT CO.
TRIM
CG RISE / ∇^1/3 X 10^2
3
2
1
0
5

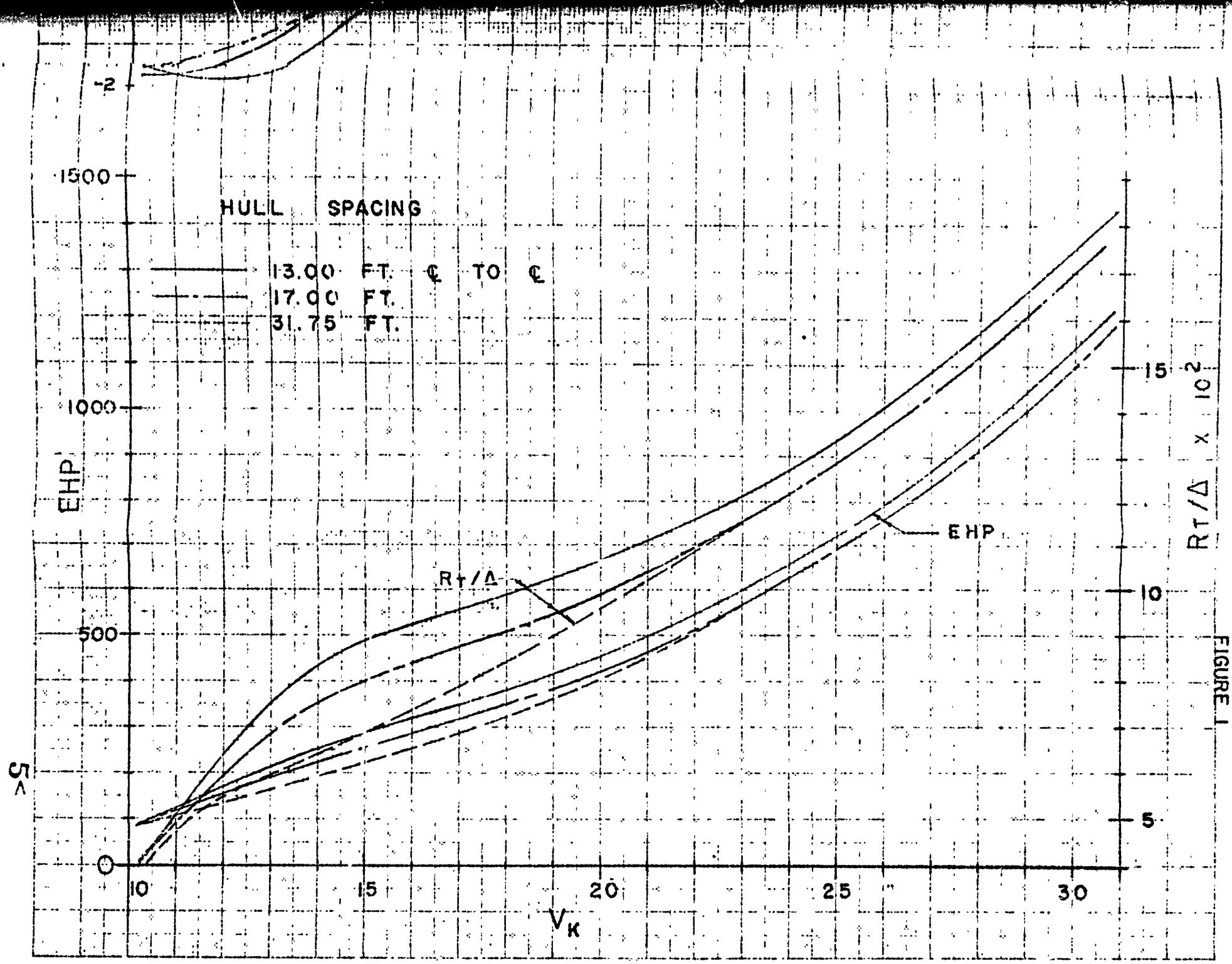
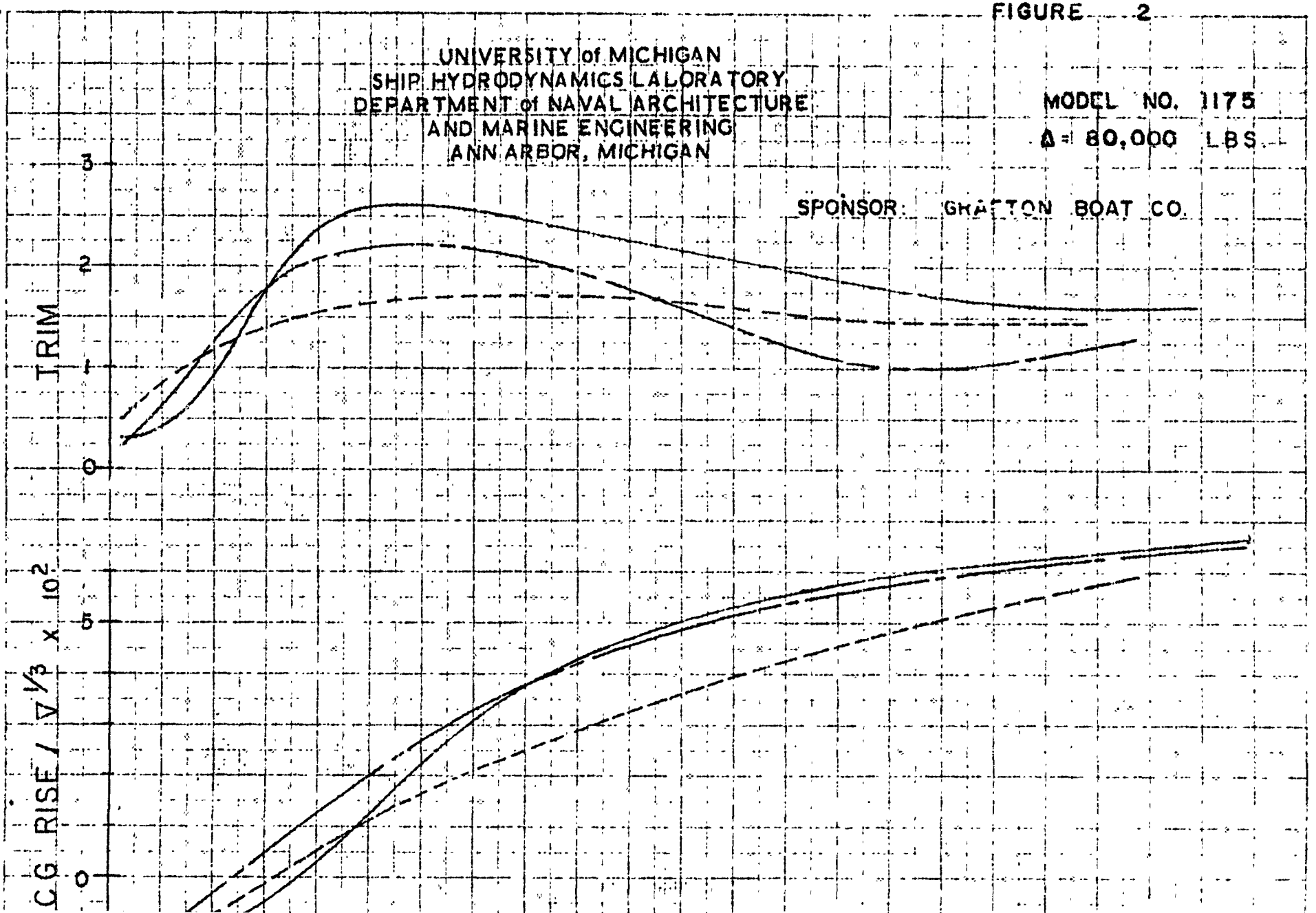

HULL SPACING
13.00 FT. ℄ TO ℄
17.00 FT.
31.75 FT.
EHP
R_T/Δ
EHP
R_T/Δ
1500
1000
500
0
10
15
20
25
30
V_K
15
10
5
R_T/Δ x 10^2
S_A

FIGURE 1

FIGURE 2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AND MARINE ENGINEERING
ANN ARBOR, MICHIGAN
MODEL NO. 1175
Δ = 80,000 LBS.
SPONSOR: GRATTON BOAT CO.
TRIM
3
2
1
0
C.G. RISE / ∇^1/3 x 10^2
5
0

FIGURE 2

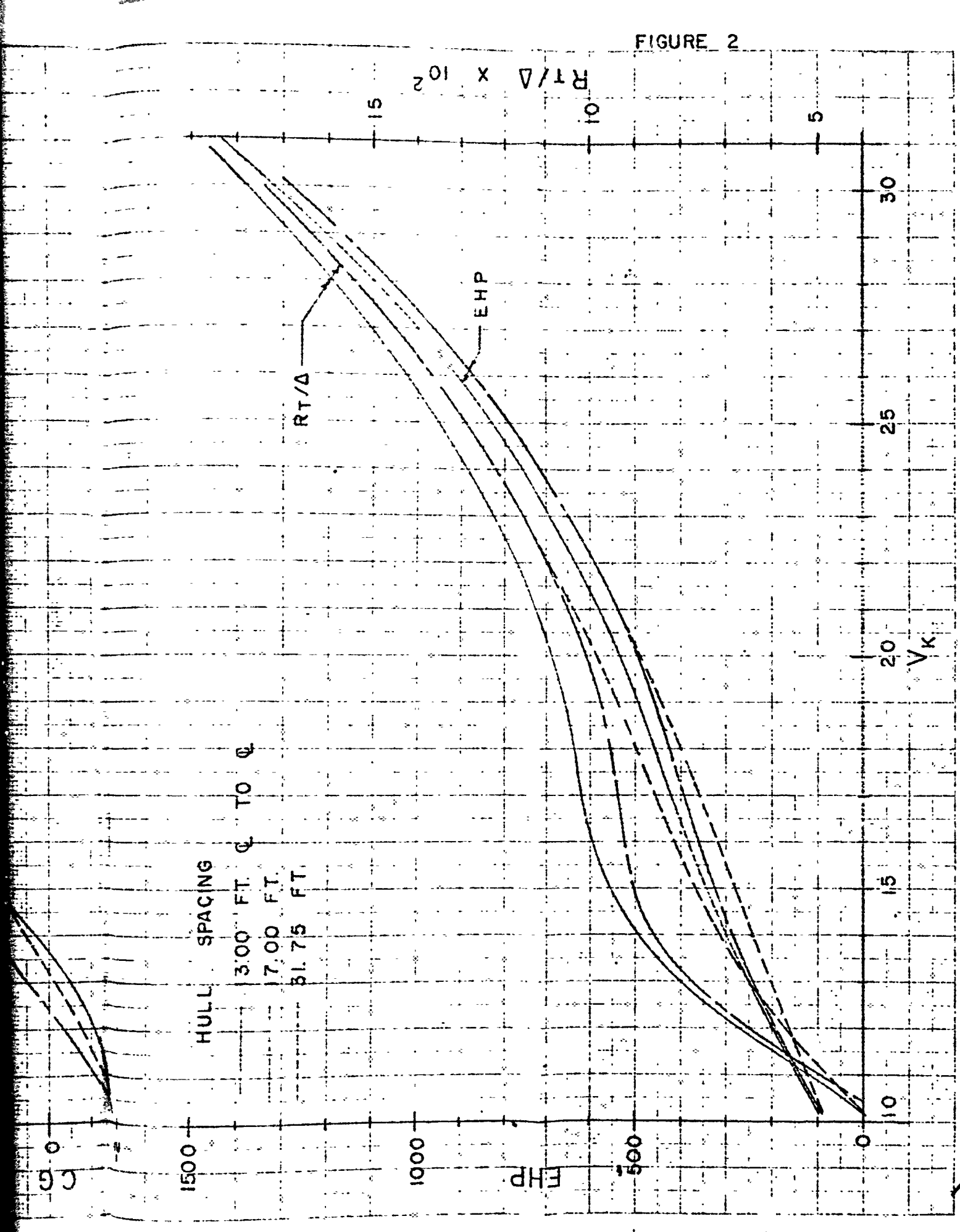
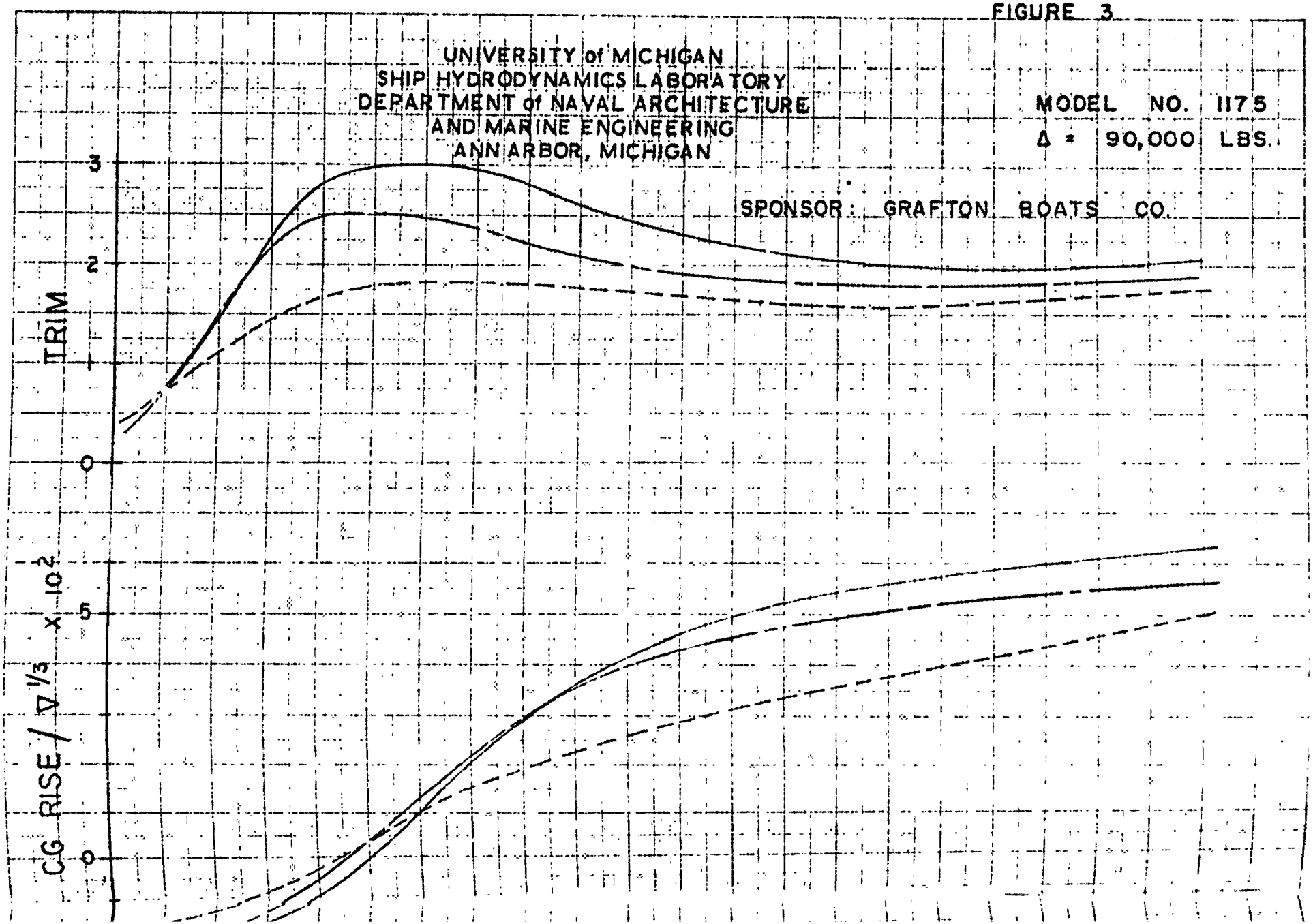

$R_T/\Delta \times 10^2$
15
10
5
30
25
20
15
10
V_K
EHP
R_T/Δ
HULL SPACING
13.00 FT. ℄ TO ℄
17.00 FT.
81.75 FT.
1500
1000
500
0
EHP
CG
0

FIGURE 3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AND MARINE ENGINEERING
ANN ARBOR, MICHIGAN
MODEL NO. 1175
Δ = 90,000 LBS.
SPONSOR: GRAFTON BOATS CO.
TRIM
3
2
1
0
CG RISE / ∇ 1/3 x 10²
5
0

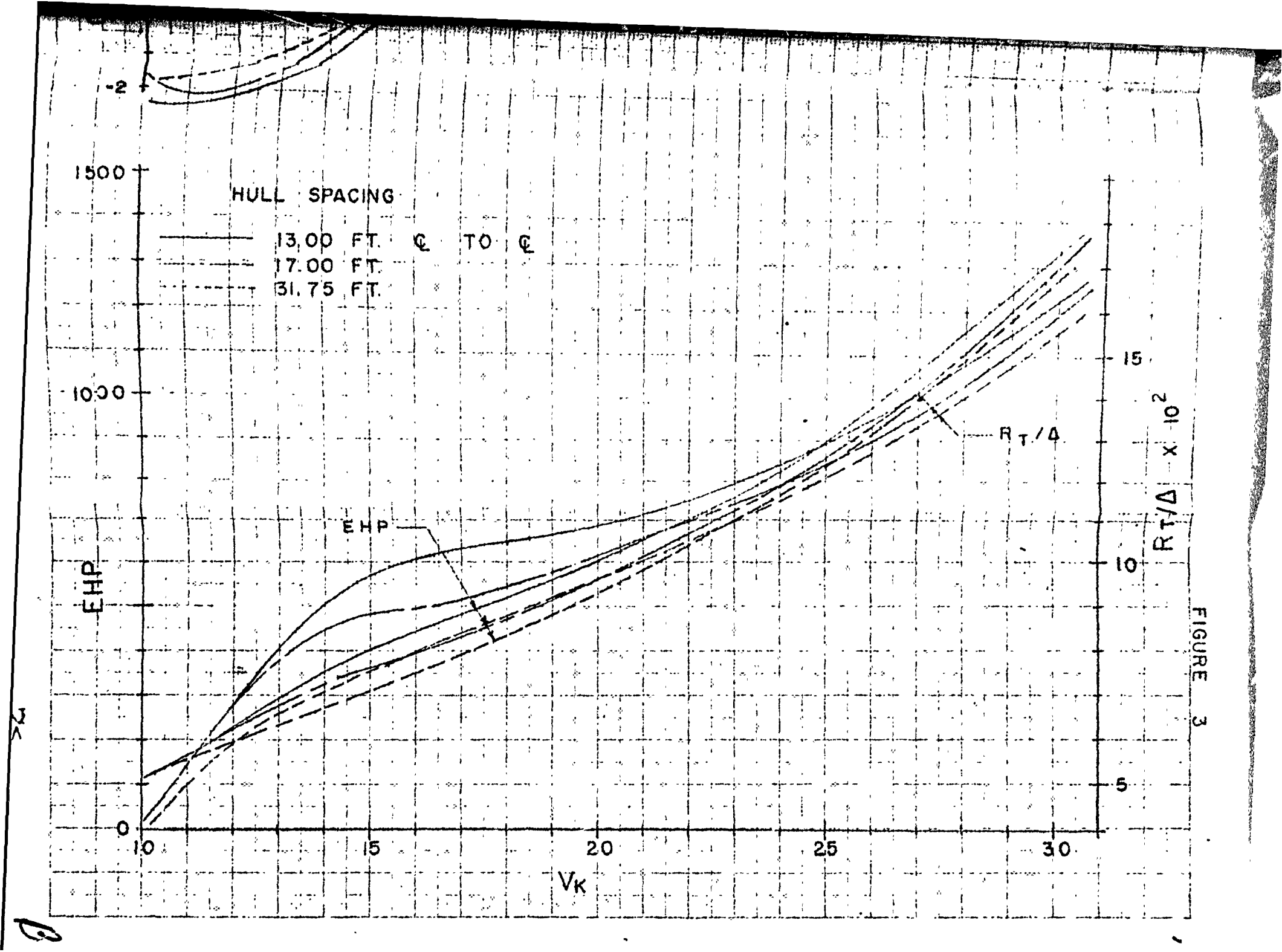
HULL SPACING
13.00 FT. ℄ TO ℄
17.00 FT.
31.75 FT.
EHP
R_T/Δ
EHP
$R_T/\Delta \times 10^2$
V_K
1500
1000
0
-2
10
15
20
25
30
15
10
5

FIGURE 3

FIGURE 4

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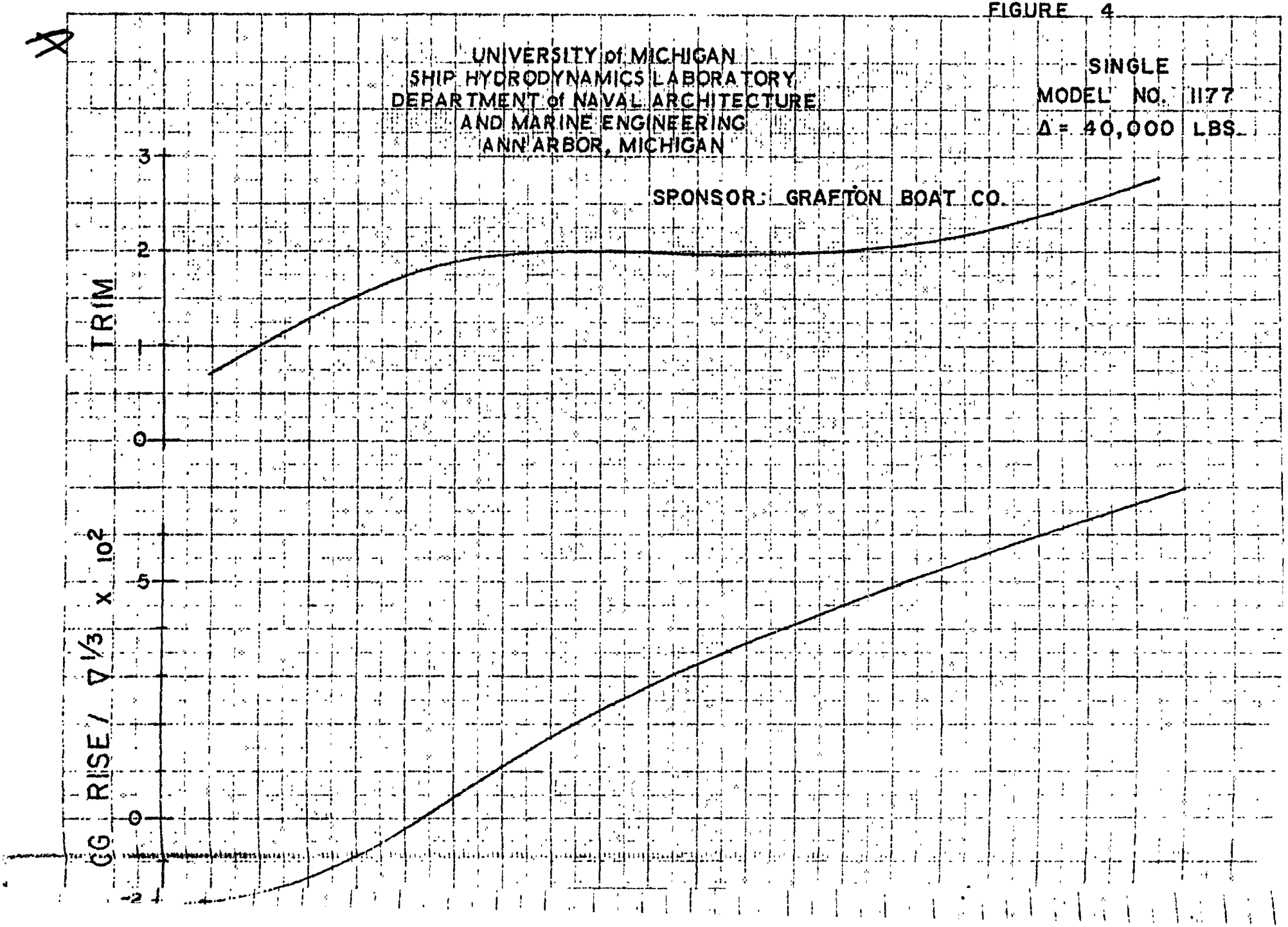
SINGLE
MODEL NO. 1177
Δ = 40,000 LBS.

SPONSOR: GRAFTON BOAT CO.



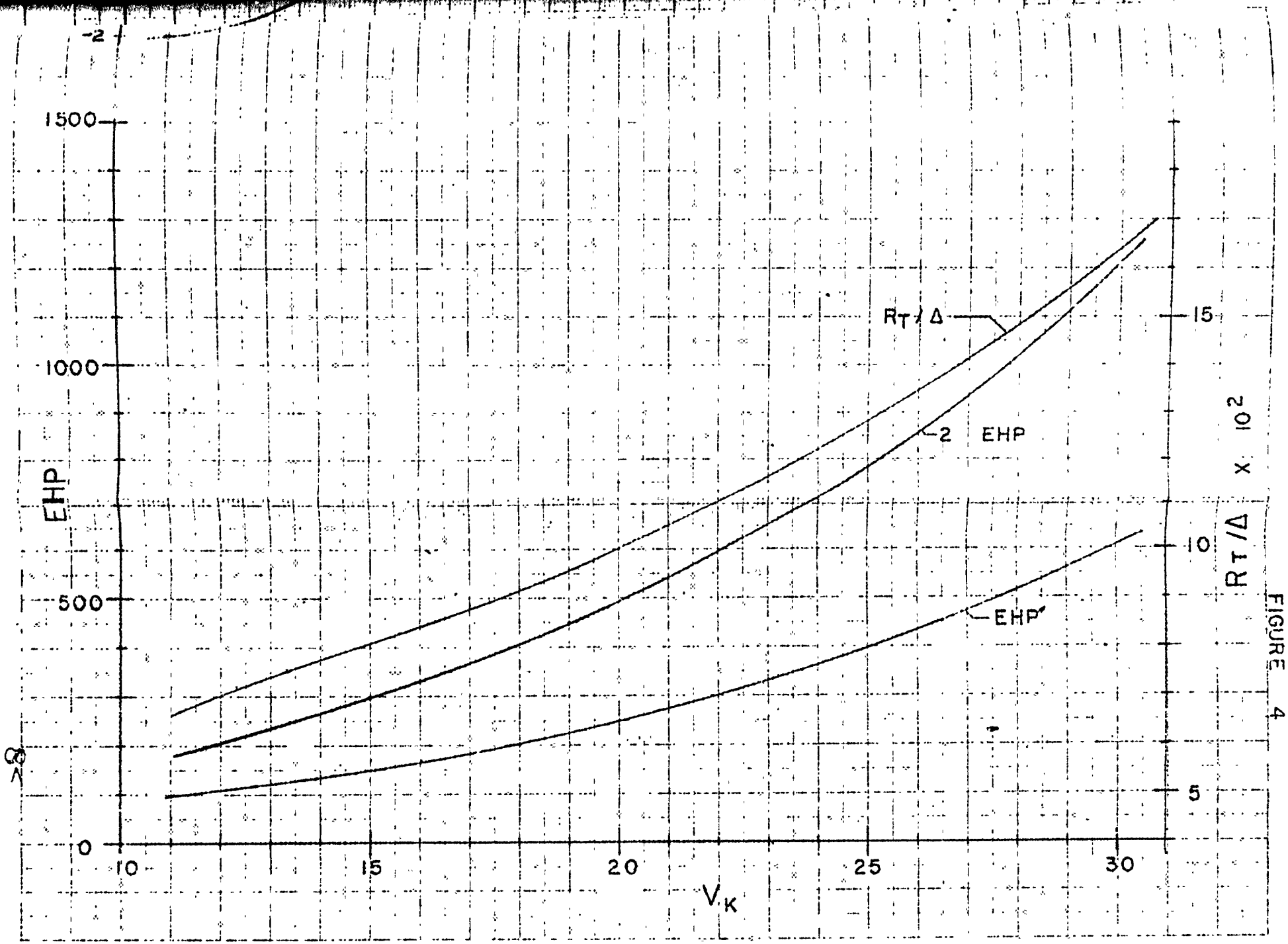

-2
1500
1000
500
0
EHP
R_T/Δ
15
10
5
R_T/Δ x 10^2
2 EHP
EHP'
10
15
20
25
30
V_K

FIGURE 4

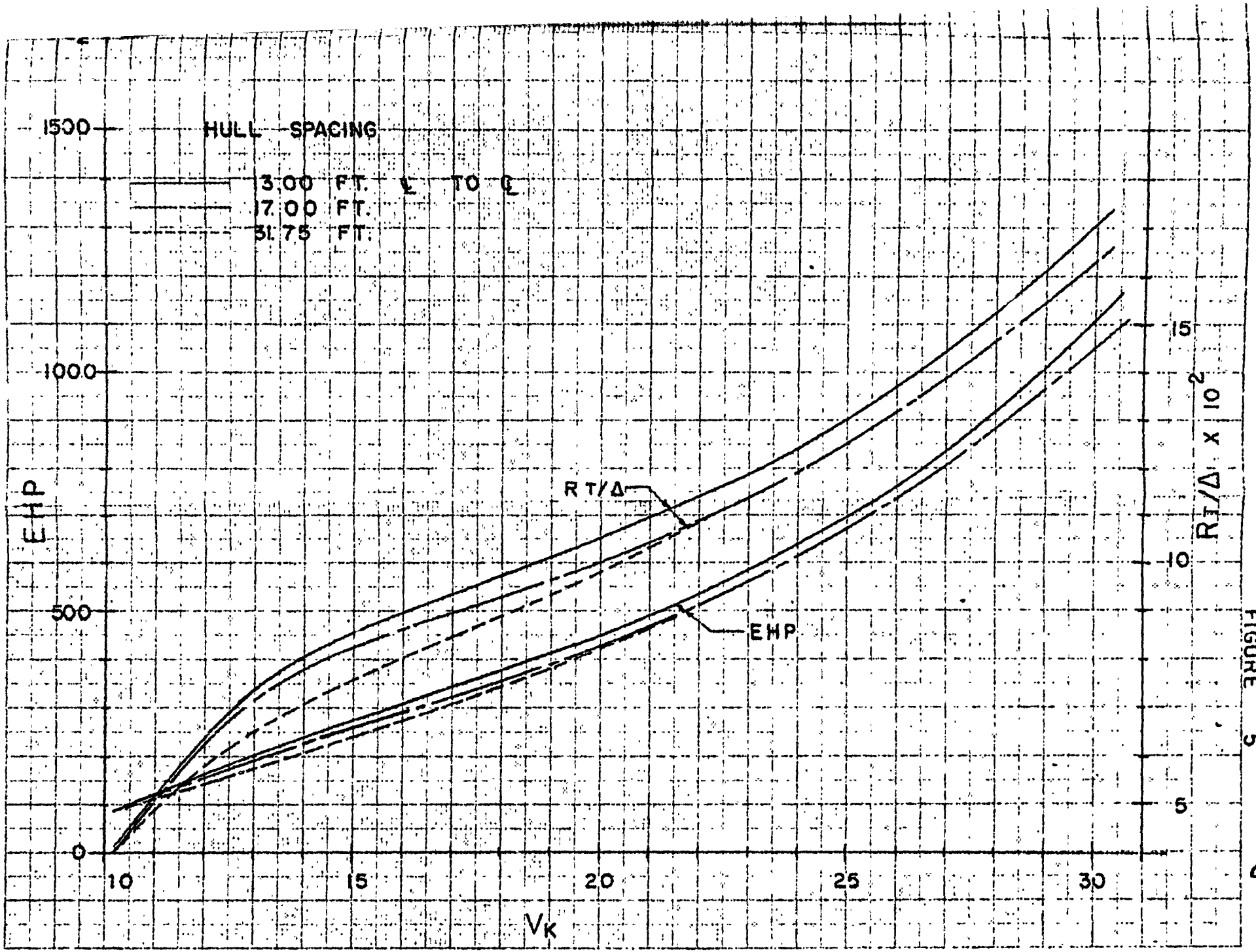
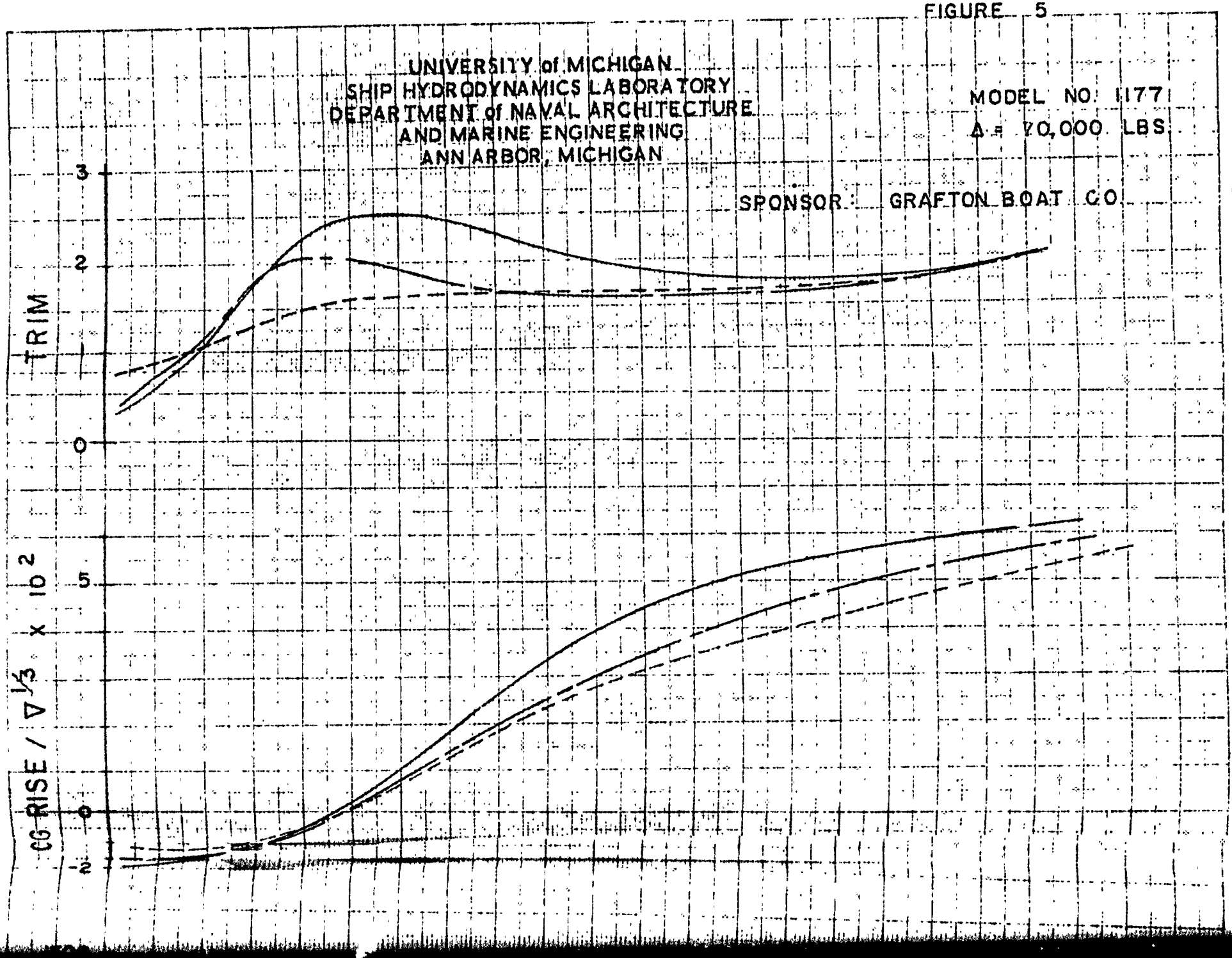

HULL SPACING
3.00 FT. ℄ TO ℄
17.00 FT.
31.75 FT.
EHP
1500
1000
500
0
10
15
20
25
30
V_K
R T/Δ
EHP
R T/Δ x 10^2
15
10
5

FIGURE 5

FIGURE 5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DEPARTMENT of NAVAL ARCHITECTURE
AND MARINE ENGINEERING
ANN ARBOR, MICHIGAN
MODEL NO. 1177
Δ = 70,000 LBS
SPONSOR: GRAFTON BOAT CO.
TRIM
CG RISE / ∇^1/3 x 10^2
3
2
0
5
0
-2

FIGURE 6

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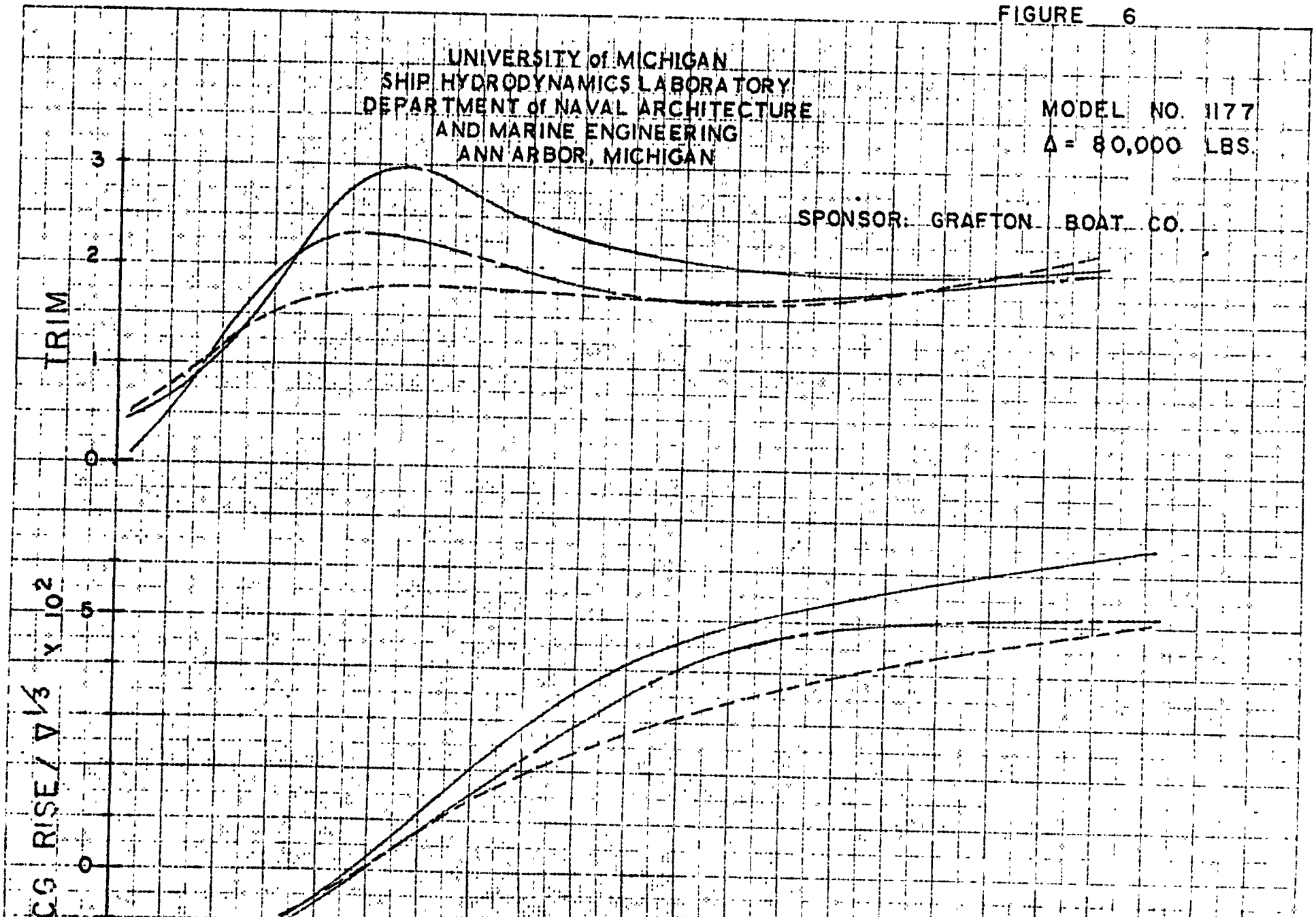
AND MARINE ENGINEERING
ANN ARBOR, MICHIGAN

MODEL NO. 1177
Δ = 80,000 LBS.

SPONSOR: GRAFTON BOAT CO.



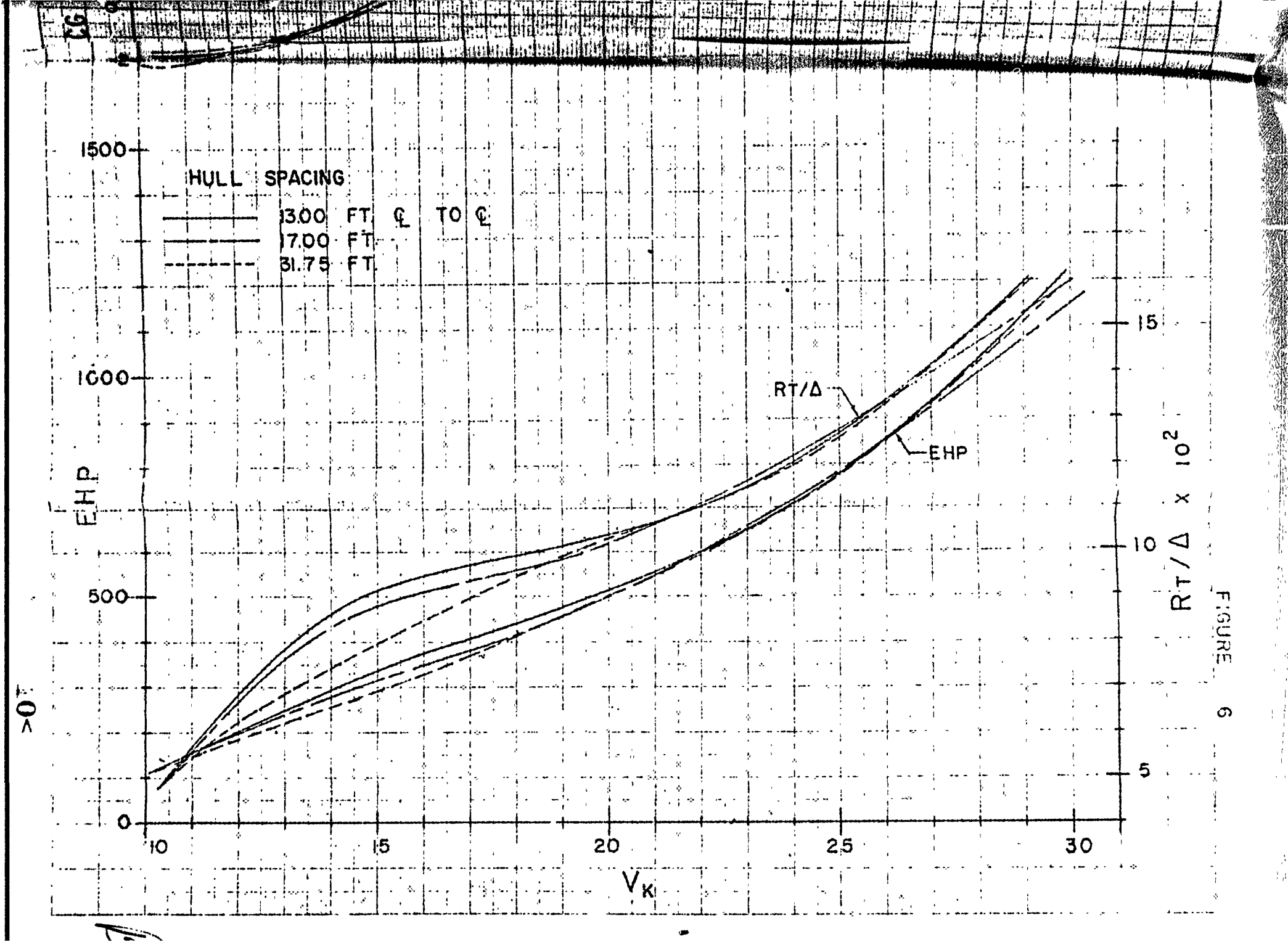

HULL SPACING
33.00 FT. ℄ TO ℄
17.00 FT.
31.75 FT.
1500
1000
500
0
EHP
RT/Δ
EHP
15
10
5
RT/Δ x 10²
10
15
20
25
30
VK

FIGURE 6

FIGURE 7

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AND MARINE ENGINEERING
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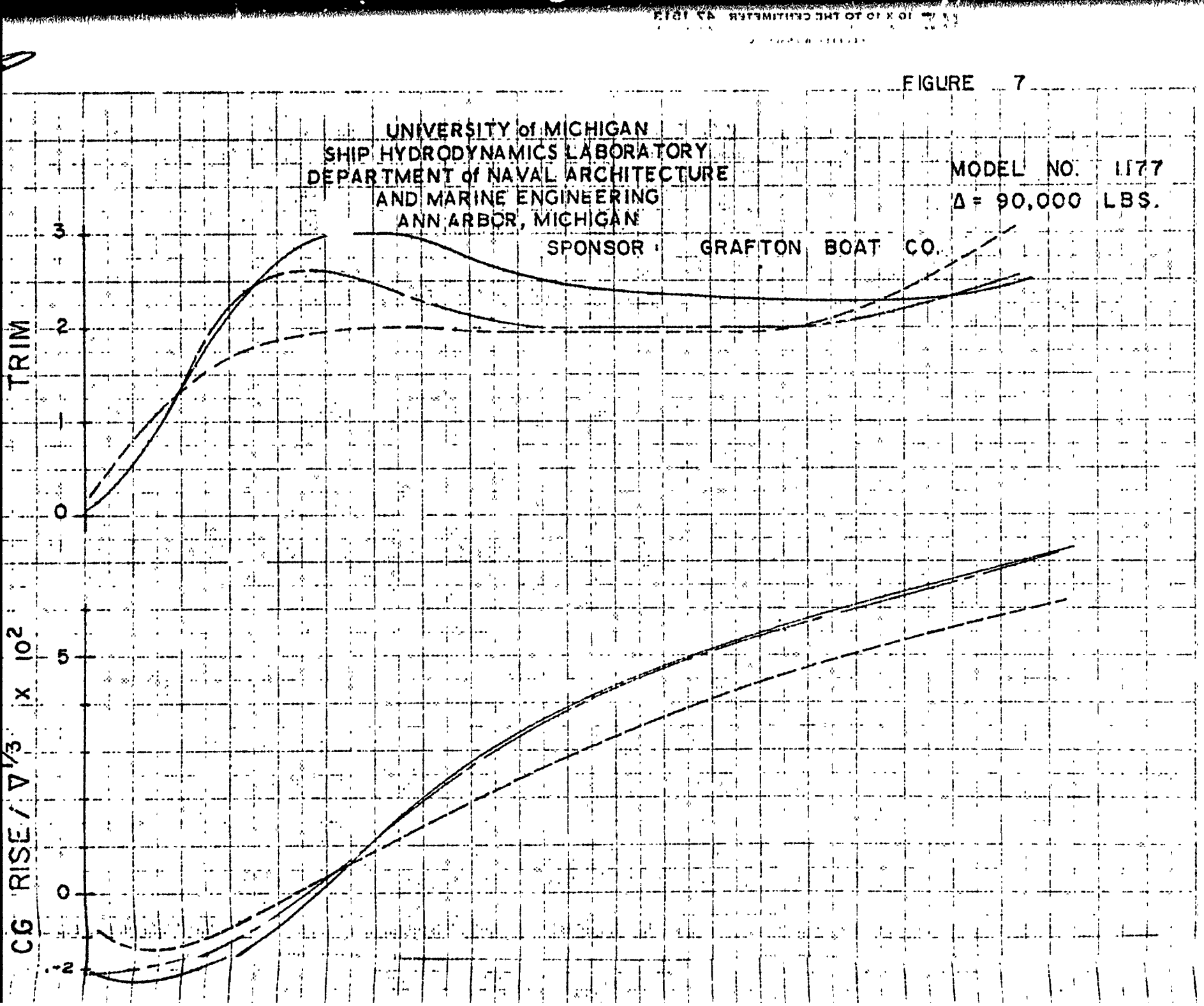
MODEL NO. 1177
Δ = 90,000 LBS.

SPONSOR : GRAFTON BOAT CO.



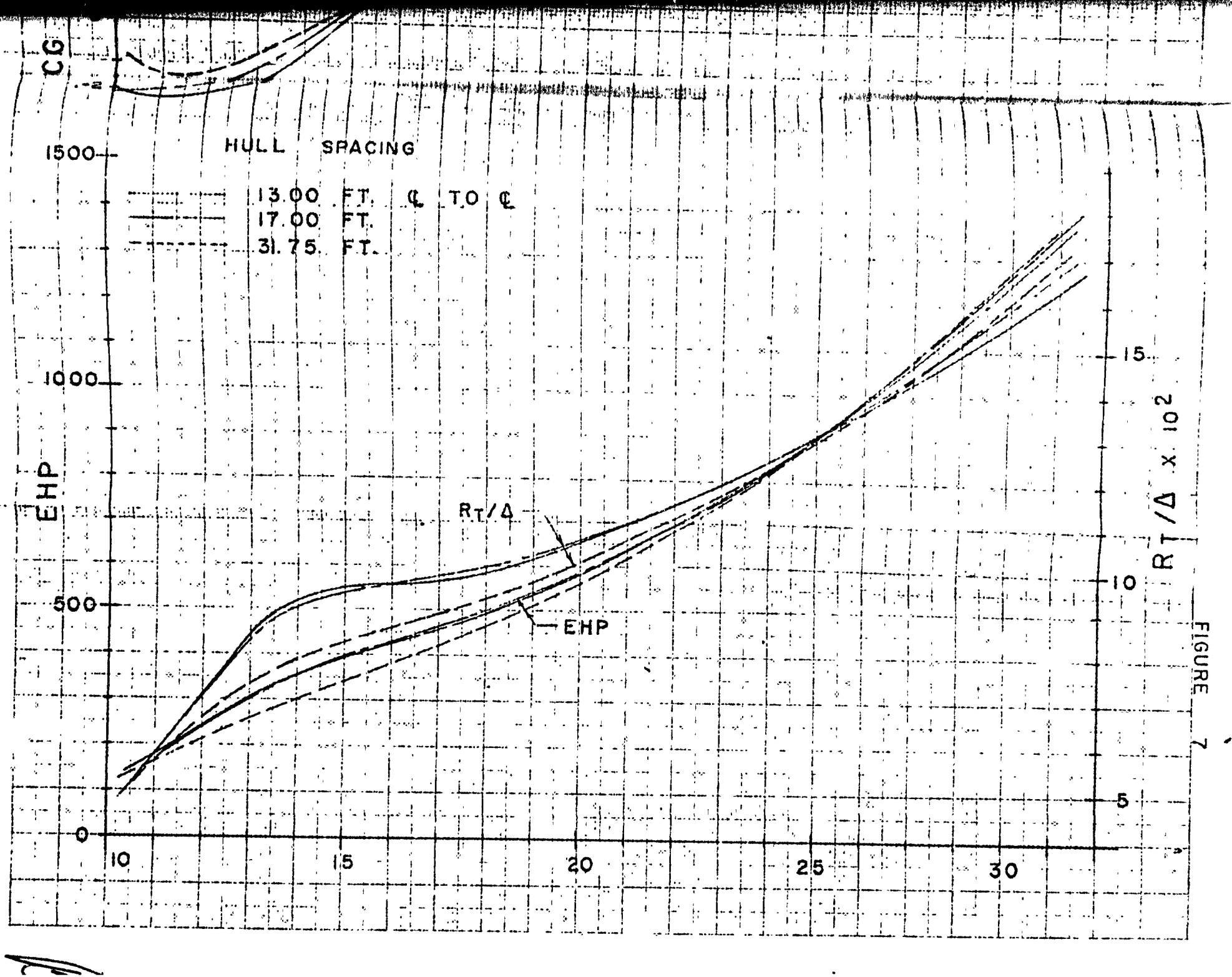
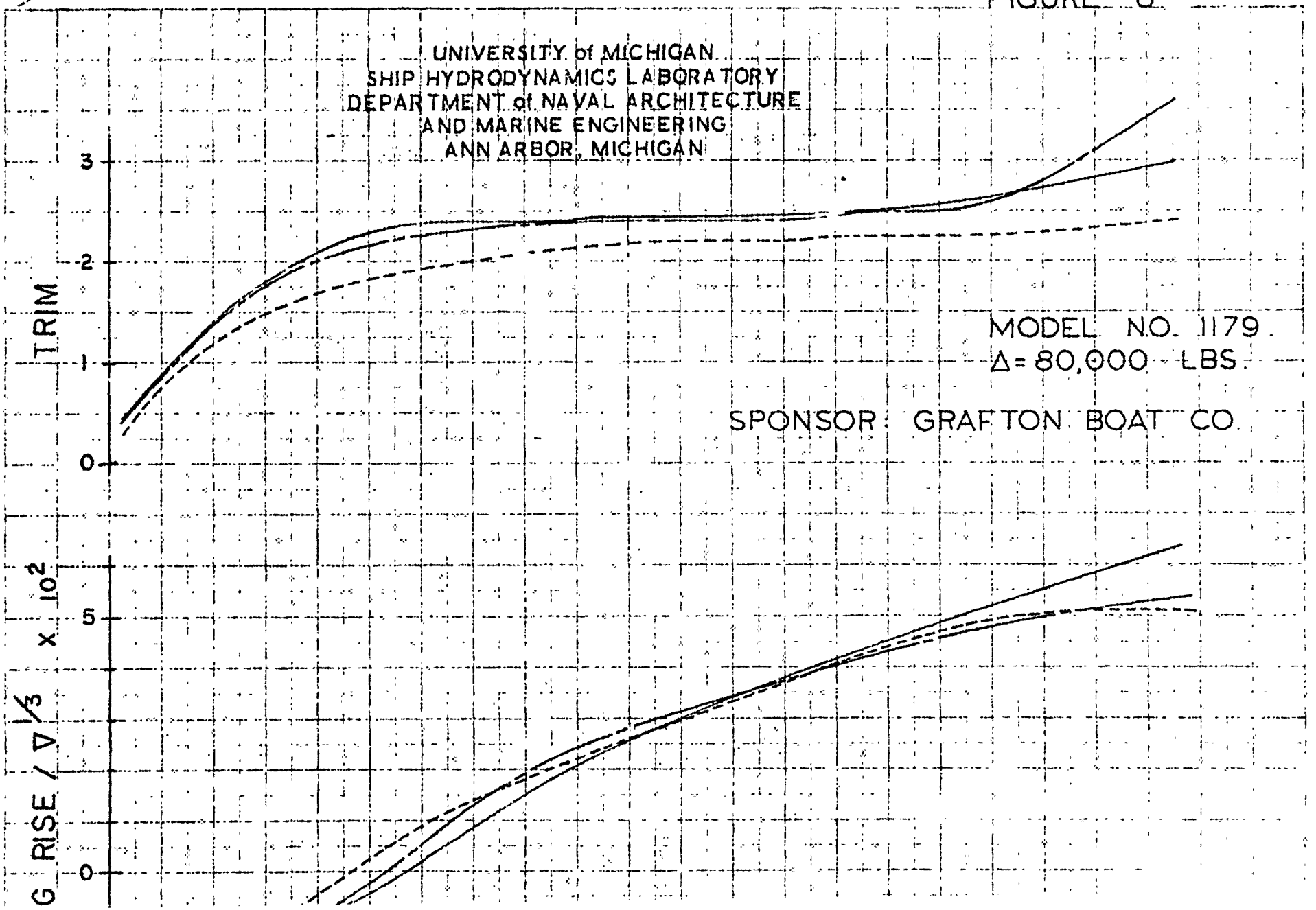

CG
HULL SPACING
13.00 FT. ℄ TO ℄
17.00 FT.
31.75 FT.
1500
1000
500
0
EHP
R_T/Δ
EHP
10
15
20
25
30
15
10
5
$R_T/\Delta \times 10^2$

FIGURE 7

FIGURE 8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AND MARINE ENGINEERING
ANN ARBOR, MICHIGAN
TRIM
3
2
1
0
MODEL NO. 1179
Δ = 80,000 LBS
SPONSOR: GRAFTON BOAT CO.
G RISE / ∇^1/3 x 10^2
5
0

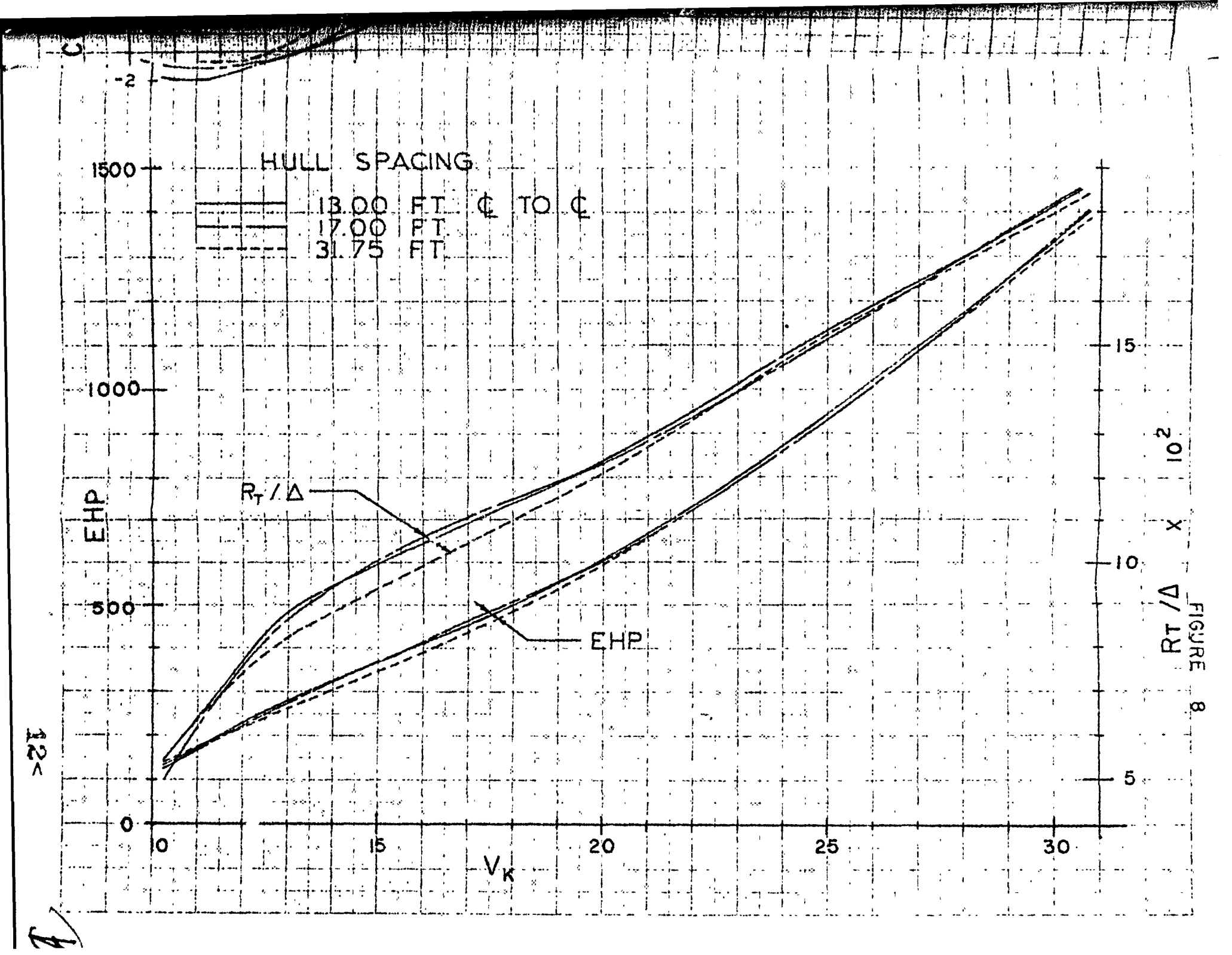
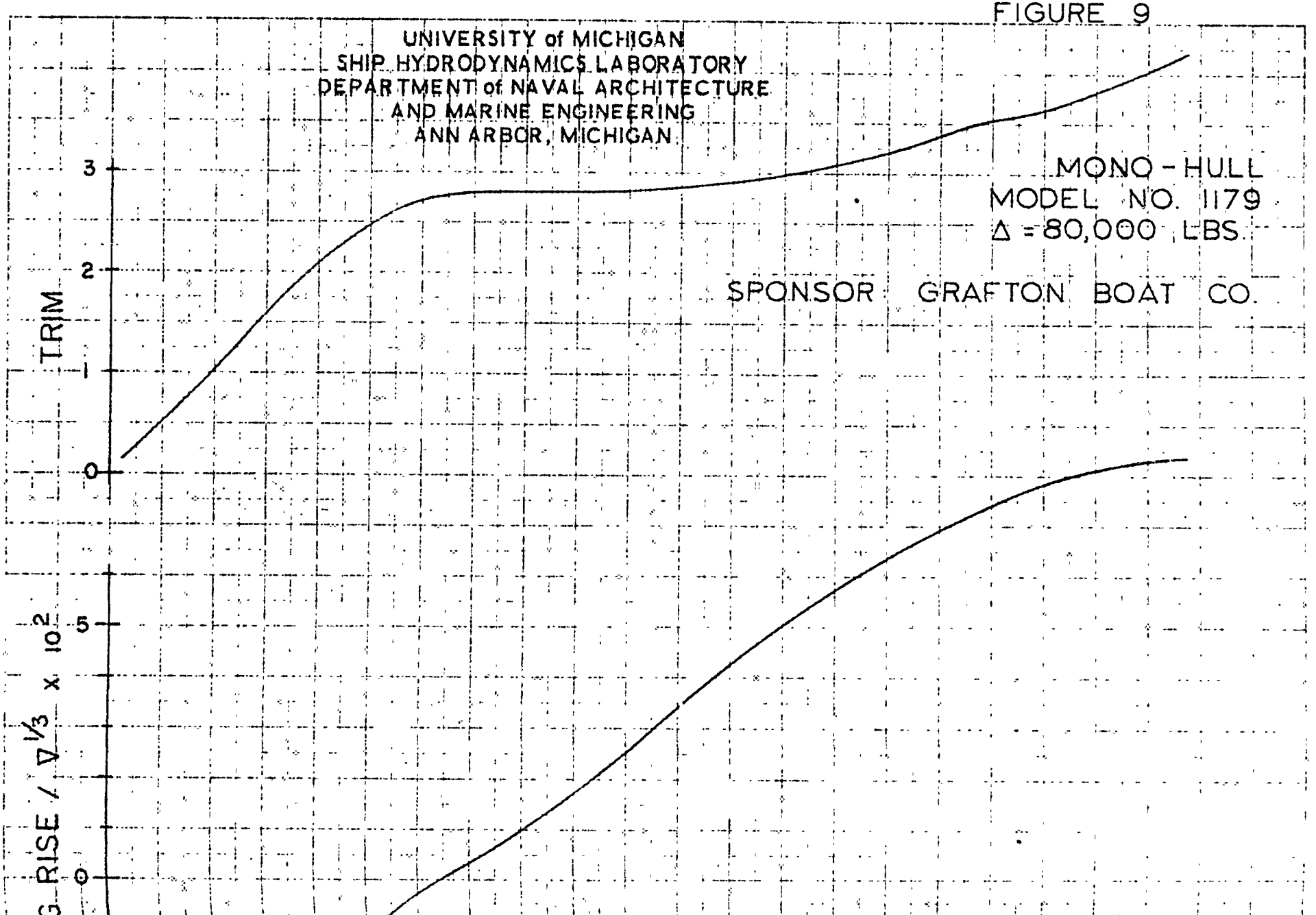

HULL SPACING
13.00 FT ℄ TO ℄
17.00 FT
31.75 FT
EHP
R_T/Δ
EHP
V_K
$R_T/\Delta \times 10^2$
1500
1000
500
0
-2
15
10
5
10
15
20
25
30

FIGURE 8

FIGURE 9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DEPARTMENT of NAVAL ARCHITECTURE
AND MARINE ENGINEERING
ANN ARBOR, MICHIGAN
MONO - HULL
MODEL NO. 1179
Δ = 80,000 LBS.
SPONSOR GRAFTON BOAT CO.
TRIM
3
2
1
0
SINKAGE RISE / ∇^1/3 x 10^2
5
0

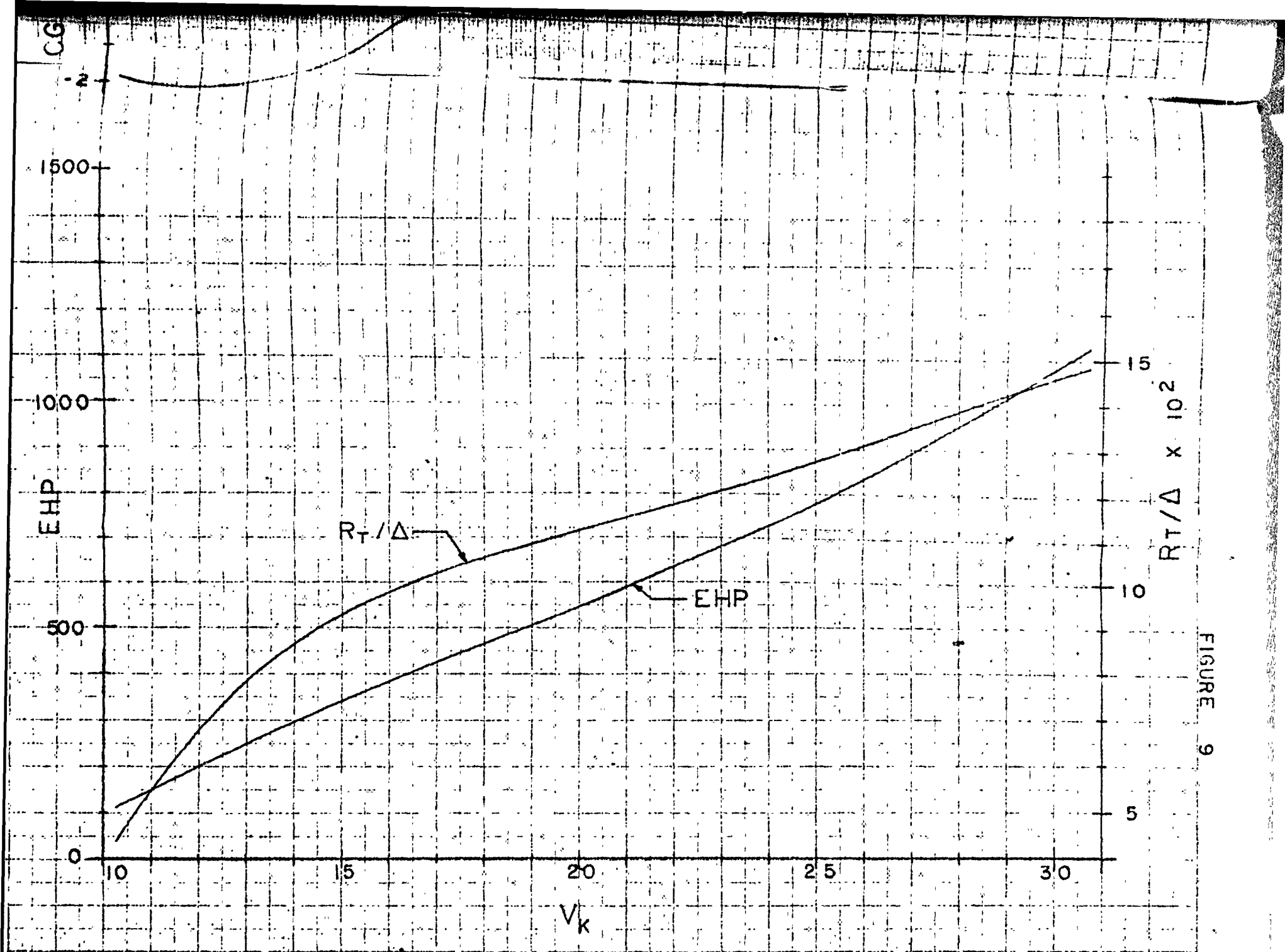
CG
-2
1500
1000
500
0
EHP
R_T/Δ
EHP
10
15
20
25
30
V_k
15
10
5
$R_T/\Delta \times 10^2$

FIGURE 9

APPENDIX
Model Data

Test No.		1175-A1			1175-B1			1175-C1		
Water Temp., ^{o}F		71.0			71.0			70.0		
	V f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
	5.00	1.92	7.62	4.99	1.88	7.69	4.99	1.85	7.63	4.99
	5.50	2.49	7.67	4.99	2.38	7.64	4.99	2.27	7.57	4.99
	6.00	3.07	7.67	4.81	2.88	7.49	4.99	2.62	7.50	4.99
	6.50	3.59	7.58	4.81	3.29	7.28	4.81	2.85	7.40	4.81
	7.00	3.92	7.35	4.81	3.55	7.08	4.81	3.09	7.24	4.81
	7.50	4.13	7.06	4.81	3.77	6.94	4.81	3.35	7.08	4.81
	8.00	4.32	6.91	4.81	3.97	6.80	4.81	3.63	6.98	4.81
	8.50	4.50	6.79	4.81	4.16	6.71	4.81	3.90	6.89	4.81
	9.00	4.70	6.66	4.81	4.37	6.63	4.81	4.20	6.83	4.81
	9.50	4.92	6.59	4.81	4.60	6.58	4.59	4.49	6.76	4.81
	10.00	5.20	6.49	4.59	4.89	6.54	4.59	4.78	6.70	4.59
	11.00	5.74	6.42	4.59	5.51	6.44	4.59	5.51	6.60	4.59
	12.00	6.35	6.35	4.59	6.19	6.36	4.59	6.22	6.54	4.59
	13.00	7.11	6.26	4.59	6.93	6.28	4.59	7.01	6.49	4.59
	14.00	8.00	6.18	4.35	7.80	6.22	4.35	7.48	6.47	4.59
	15.00	8.96	6.08	4.35	8.78	6.15	4.35	8.78	6.44	4.59

Test No.	1175-A2			1175-B2			1175-C2		
Water Temp., ^{o}F	71.0			71.0			71.0		
v f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
5.00	2.15	7.97	4.99	1.95	8.01	4.99	2.17	7.97	4.99
5.50	2.94	7.95	4.99	2.80	7.84	4.99	2.64	7.89	4.99
6.00	3.66	7.84	4.99	3.51	7.57	4.81	3.09	7.76	4.81
6.50	4.25	7.65	4.81	4.10	7.33	4.81	3.50	7.60	4.81
7.00	4.64	7.38	4.81	4.47	7.13	4.81	3.83	7.43	4.817
7.50	4.97	7.09	4.81	4.66	7.00	4.81	4.11	7.26	4.81
8.00	5.16	6.87	4.81	4.81	6.90	4.81	4.37	7.14	4.81
8.50	5.31	6.72	4.81	4.96	6.81	4.81	4.65	7.04	4.81
9.00	5.46	6.63	4.81	5.10	6.72	4.81	4.91	6.97	4.81
9.50	5.64	6.56	4.59	5.30	6.65	4.81	5.19	6.90	4.81
10.00	5.87	6.49	4.59	5.50	6.60	4.81	5.46	6.83	4.81
11.00	6.46	6.40	4.59	6.10	6.53	4.81	6.13	6.71	4.81
12.00	7.19	6.37	4.59	6.88	6.47	4.81	6.90	6.59	4.81
13.00	8.04	6.34	4.59	7.84	6.41	4.59	7.80	6.50	4.59
14.00	9.05	6.31	4.59	8.80	6.35	4.59			
15.00	10.15	6.27	4.59						

Test No.	1175-A3			1175-B3			1175-C3		
Water Temp., ^{o}F	71.0			71.0			71.0		
v f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
5.00	2.56	8.53	4.99	2.46	8.55	4.99	2.42	8.39	4.99
5.50	3.39	8.51	4.99	3.32	8.48	4.99	3.14	8.34	4.99
6.00	4.12	8.42	4.99	4.06	8.35	4.99	3.63	8.25	4.99
6.50	4.79	8.29	4.81	4.58	8.08	4.99	3.91	8.08	4.99
7.00	5.31	7.98	4.81	4.93	7.78	4.81	4.20	7.88	4.81
7.50	5.63	7.63	4.81	5.10	7.58	4.81	4.49	7.71	4.81
8.00	5.80	7.43	4.81	5.25	7.41	4.81	4.77	7.57	4.81
8.50	5.97	7.28	4.59	5.43	7.24	4.81	5.08	7.49	4.81
9.00	6.14	7.13	4.59	5.66	7.13	4.81	5.39	7.42	4.81
9.50	6.29	7.01	4.59	5.91	7.04	4.81	5.68	7.36	4.81
10.00	6.50	6.91	4.59	6.20	6.99	4.81	5.97	7.31	4.81
11.00	7.05	6.84	4.59	6.80	6.85	4.59	6.59	7.21	4.59
12.00	7.73	6.76	4.59	7.46	6.80	4.59	7.34	7.11	4.59
13.00	8.53	6.18	4.35	8.28	6.74	4.59	8.20	7.04	4.59
14.00	9.40	6.67	4.35	9.21	6.72	4.59	9.11	6.97	4.59
15.00				10.24	6.68	4.59	10.13	7.81	4.59

Test No.	1177-Single Hull			1177-A1			1177-B1		
Water Temp., ^{o}F	71.0			71.0			71.0		
V f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
5.00				1.99	8.00	4.89	1.95	7.92	4.89
5.50	1.72	4.14	4.89	2.56	7.95	4.89	2.50	7.92	4.89
6.00	1.85	4.11	4.89	3.10	7.88	4.89	3.01	7.85	4.89
6.50	1.95	4.06	4.89	3.50	7.73	4.89	3.41	7.65	4.89
7.00	2.05	3.98	4.89	3.81	7.49	4.89	3.69	7.42	4.89
7.50	2.17	3.90	4.89	4.04	7.29	4.89	3.90	7.28	4.89
8.00	2.27	3.83	4.89	4.24	7.14	4.67	4.10	7.19	4.89
8.50	2.39	3.78	4.89	4.47	7.01	4.67	4.28	7.10	4.89
9.00	2.51	3.72	4.89	4.70	6.88	4.67	4.54	7.03	4.89
9.50	2.65	3.68	4.89	4.92	6.74	4.67	4.77	6.94	4.89
10.00	2.80	3.64	4.89	5.15	6.60	4.67	4.98	6.86	4.67
11.00	3.15	3.58	4.67	5.63	6.55	4.67	5.44	6.70	4.67
12.00	3.51	3.53	4.67	6.26	6.48	4.67	6.09	6.58	4.67
13.00	3.89	3.46	4.67	6.95	6.40	4.44	6.78	6.47	4.67
14.00	4.29	3.40	4.66	7.84	6.32	4.44	7.51	6.38	4.44
15.00	4.77	3.34	4.67	8.78	6.24	4.44	8.44	6.28	4.44

Test No.	1177-C1			1177-A2			1177-B2		
Water Temp., ^{o}F	71.0			71.0			71.0		
V f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
5.00	1.92	7.85	4.89	2.50	8.35	4.89	2.48	8.40	4.89
5.50	2.40	7.88	4.89	3.10	8.35	4.89	3.04	8.35	4.89
6.00	2.81	7.83	4.89	3.67	8.26	4.89	3.56	8.26	4.89
6.50	3.14	7.74	4.89	4.17	8.06	4.89	4.04	8.01	4.89
7.00	3.42	7.60	4.89	4.57	7.83	4.89	4.39	7.76	4.89
7.50	3.68	7.45	4.89	4.78	7.56	4.89	4.63	7.63	4.89
8.00	3.92	7.27	4.89	4.97	7.36	4.89	4.79	7.52	4.89
8.50	4.14	7.13	4.89	5.16	7.18	4.89	4.97	7.40	4.89
9.00	4.37	7.04	4.89	5.32	7.04	4.89	5.17	7.30	4.89
9.50	4.64	6.97	4.89	5.50	6.95	4.89	5.43	7.18	4.89
10.00	4.90	6.90	4.67	5.68	6.89	4.67	5.65	7.06	4.89
11.00	5.54	6.81	4.67	6.18	6.82	4.67	6.29	6.88	4.89
12.00	6.12	6.72	4.67	6.85	6.76	4.67	6.93	6.78	4.67
13.00	6.88	6.64	4.67	7.72	6.69	4.67	7.65	6.76	4.67
14.00	7.51	6.51	4.67				8.36	6.76	4.67
15.00	8.51	6.38	4.44						

Test No.		1177-C2			1177-A3			1177-B3	
Water Temp., ^{o}F		71.0			71.0			71.0	
v f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
5.00	2.45	8.31	4.89	2.81	8.74	4.89	2.78	8.74	4.89
5.50	2.97	8.25	4.89	3.55	8.78	4.89	3.47	8.67	4.89
6.00	3.36	8.19	4.89	4.31	8.74	4.89	4.21	8.53	4.89
6.50	3.68	8.09	4.89	4.99	8.53	4.89	4.86	8.32	4.89
7.00	3.98	7.91	4.89	5.30	8.13	4.89	5.23	8.06	4.89
7.50	4.30	7.72	4.89	5.45	7.86	4.89	5.43	7.92	4.89
8.00	4.59	7.60	4.89	5.52	7.70	4.89	5.61	7.79	4.89
8.50	4.89	7.46	4.89	5.66	7.54	4.89	5.77	7.66	4.89
9.00	5.18	7.37	4.89	5.89	7.41	4.89	5.95	7.51	4.89
9.50	5.44	7.30	4.89	6.13	7.35	4.89	6.17	7.41	4.89
10.00	5.70	7.24	4.89	6.45	7.26	4.67	6.43	7.31	4.67
11.00	6.21	7.14	4.67	7.08	7.15	4.67	7.05	7.15	4.67
12.00	6.85	7.06	4.67	7.83	7.07	4.67	7.82	7.01	4.67
13.00	7.77	6.97	4.67	8.62	6.94	4.44	8.72	6.90	4.67
14.00	8.94	6.91	4.67	9.51	6.85	4.44			
15.00									

Test No.	1177-C3			1179-A2			1179-B2		
Water Temp., ^{o}F	71.0			70.0			71.0		
v f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
5.00	2.65	8.49	4.89	2.81	8.97	4.91	2.61	8.89	4.85
5.50	3.26	8.57	4.89	3.45	8.97	4.91	3.39	8.91	4.85
6.00	3.85	8.52	4.89	4.11	8.90	4.91	4.09	8.88	4.85
6.50	4.33	8.39	4.89	4.63	8.78	4.85	4.61	8.78	4.85
7.00	4.66	8.22	4.89	4.96	8.65	4.85	4.97	8.51	4.85
7.50	4.89	8.04	4.89	5.25	8.42	4.85	5.29	8.14	4.65
8.00	5.12	7.88	4.89	5.51	8.11	4.85	5.57	8.10	4.65
8.50	5.35	7.75	4.89	5.78	7.71	4.85	5.85	7.72	4.65
9.00	5.62	7.65	4.89	6.07	7.65	4.85	6.11	7.59	4.65
9.50	5.91	7.54	4.89	6.37	7.49	4.85	6.36	7.49	4.65
10.00	6.42	7.43	4.67	6.70	7.39	4.65	6.65	7.40	4.65
11.00	6.95	7.29	4.67	7.38	7.19	4.65	7.32	7.26	4.65
12.00	7.76	7.17	4.67	8.14	7.01	4.65	8.05	7.12	4.65
13.00	8.69	7.06	4.67	8.82	6.87	4.65	8.79	7.01	4.43
14.00	9.72	6.95	4.67	9.51	6.72	4.65	9.56	6.89	4.43
15.00									

Test No.	1179-C2			Mono-Hull		
Water Temp., ^{o}F	71.0			70.0		
V f/s	R_T lbs.	S ft^2	L ft.	R_T lbs.	S ft^2	L ft.
5.00	2.80	8.79	4.91	2.24	6.26	4.85
5.50	3.42	8.88	4.91	2.95	6.26	4.85
6.00	3.98	8.84	4.91	3.55	6.26	4.85
6.50	4.34	8.70	4.85	4.05	6.26	4.65
7.00	4.67	8.44	4.85	4.45	6.24	4.65
7.50	4.94	8.07	4.85	4.80	6.23	4.65
8.00	5.28	7.89	4.85	5.06	6.22	4.65
8.50	5.58	7.76	4.85	5.30	6.20	4.65
9.00	5.90	7.69	4.85	5.52	6.17	4.43
9.50	6.25	7.58	4.65	5.73	6.15	4.43
10.00	6.60	7.50	4.65	5.93	6.13	4.43
11.00	7.32	7.33	4.65	6.34	6.06	4.43
12.00	8.09	7.17	4.65	6.80	5.97	4.43
13.00	8.80	7.01	4.65	7.29	5.86	4.43
14.00	9.49	6.95	4.65	7.80	5.72	4.43
15.00				8.32	5.54	3.83